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Revision of the West-Mediterranean geometrid genus *Ekboarmia*, with description of a new species from Portugal (Lepidoptera, Geometridae, Ennominae)

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Abstract. The West-Mediterranean geometrid moth genus *Ekboarmia* Wehrli, 1943 (Lepidoptera: Geometridae, Ennominae) is revised based on morphology, life history, and DNA barcodes. It was found that wing patterns allow reliable identification of species, whereas the genitalia are rather uniform in shape and less informative, and the genetic divergence (in the COI gene) between species is considerably lower than in the Geometridae on average, ranging 1.5–3.9%. Four species are considered as valid: *E. atlanticaria* (Staudinger, 1859), with one putative subspecies in North Africa, *E. fascinataria* (Staudinger, 1900), *E. sagnesi* Dufay, 1979, and *E. miniaria* **sp. n.** from Portugal. *Boarmia atlanticaria gracilis* Albers & Warnecke, 1941 is downgraded to junior synonym of *Boarmia*(?) *atlanticaria atlanticaria* Staudinger, 1859, **syn. n.** *E. fascinataria* is removed from the European checklist due to lack of confirmed records. Larvae, where information exists, are external feeders on *Juniperus* needles (Cupressaceae), and adults are nocturnal, inhabiting various habitats up to 1400 metres above sea level, having apparently at least two generations per year. Adults, male and female genitalia, distribution map, and diagnostic characters are illustrated for all species. Larva and pupa of *E. atlanticaria* and larva of *E. sagnesi* are illustrated, and results of DNA barcode analysis are presented for most taxa studied.

Introduction

The concept of the geometrid genus *Ekboarmia* is based on *Boarmia atlanticaria* Staudinger, 1859, a West-Mediterranean species that occurs in the Iberian Peninsula, the Balearic Islands, Sardinia, and in North Africa. This nocturnal species is small, with the wingspan ranging 19–27 mm, and the adult is characterised by grey-brown wings and forewing postmedial line, which is slightly to strongly dentate, with a deep, z-shaped incision near the forewing costa. The larva of *E. atlanticaria* is green, a needle-mimic that matches (see Fig. 6) the branches of its foodplant *Juniperus phoenicea* (Cupressaceae) (Corley 2004; Flamigni et al. 2016). Externally, the unrelated *Menophra harterti* (Rothschild, 1912) and *Ecleora solieraria* (Rambur, 1834) are very similar to *E. atlanticaria* (see Flamigni et al. (2007) for diagnostic characters).

The genus *Ekboarmia* included for a long time two externally similar yet diagnostic species, *E. atlanticaria* and *E. fascinataria* (Staudinger, 1900), the latter occurring in North Africa from Morocco to Algeria. The few articles that deal with the genus *Ekboarmia* can be summarised as follows. Albers and Warnecke (1941) illustrated type specimens of both species as photographs and the male genitalia as line drawings. They provided new faunistic information, for instance a record of *E. atlanticaria* from Sardinia, where the species was found for the first time by Bytinski-Salz (1937), and described a new subspecies of *E. atlanticaria* from Morocco. In 1979 a new *Ekboarmia* species was described, namely *E. sagnesi* from the French Alps (Dufay 1979). It differs externally from the above-mentioned species by having more uniform pale brown ground colour and fore-wing postmedial line is less angled inwards near costa. At the time of description, only males were known. Twenty-six years later Colomb (2005) described the life history and illustrated the female of *E. sagnesi*, reporting that in captivity larvae of *E. sagnesi* feed on *Juniperus* as was hypothesised by Dufay (1979). Colomb (2005) also illustrated a superficial line drawing of the corpus bursae of the female genitalia, having an unusual curved structure, not reported in other *Ekboarmia* species. More recently, a new subspecies of *E. sagnesi* was described from south-east Spain, Jaén province (Expósito Hermosa 2007), on the basis of a single male. Leraut (2009, p. 185) synonymised the taxon with a note 'general appearance and genitalia in all aspects correspond to the holotype of *sagnesi* Dufay'. The two Spanish species (*E. atlanticaria* and *E. sagnesi*) have been treated in detail by Redondo et al. (2007), the only Italian species (*E. atlanticaria*) by Flamigni et al. (2007, 2016) and the three known *Ekboarmia* species (*E. atlanticaria*, *E. sagnesi* and *E. fascinataria*) by Leraut (2009).

Between 1995 and 2011, 11 specimens of a small Geometridae, represented by both sexes, were found in Portugal, which, due to their unusual appearance could not be placed at first in any known European genus. Later the second author was able to solve this problem, through study of the large ZFMK collection. In this paper we demonstrate that these specimens belong to genus *Ekboarmia* and describe them as a species new to science, revise the entire genus, provide diagnostic characters for all taxa, and new faunistic and life history information on these moths.

Material and methods

The study is based on material housed in the following collections: Private collection of Bernd Müller, Berlin, Germany (Müller); Muséum National d'Histoire Naturelle, Paris, France (MNHN); Zoologisches Museum der Humboldt Universität, Berlin, Germany (MNHU); The Natural History Museum, London, United Kingdom (NHM); private collection of Pasi Sihvonen, Veikkola, Finland (Sihvonen); private collection of Peder Skou, Vester Skerninge, Denmark (Skou); private collection of Manfred Sommerer, München, Germany (Sommerer); private collection of Dirk Stadie, Lutherstadt Eisleben, Germany (Stadie); Stuttgart State Museum of Natural History, Stuttgart, Germany (SMNH); Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK); Zoologische Staatssammlung München, Germany (ZSM).

Distribution map is based on examination of authentic specimens, and was created by compiling label data from collection specimens. These data were supplemented by additional information from recent publications with precise distribution data including Spain and Portugal (Redondo et al. 2009) and Italy (Flamigni et al. 2007, 2016).

The taxa were delimited on the basis of combining data from various sources including morphology, biology and DNA barcodes, and applying the phylogenetic species concept of Nixon and Wheeler (1990). In the taxonomy section, the diagnostic characters are in bold italic font style.

The genitalia and the abdomen were prepared following methods described by Hardwick (1950). The phallus was photographed during dissection, and afterwards the vesica was everted from the same sample. The vesica was everted via the caecum that was cut open, by placing the phallus inside a hypodermic syringe (Sihvonen 2001). The wing venation slides were prepared by removing one pair of wings either by gentle downwards pressure or by lifting with fine forceps. The wings were then placed in a dish containing 99.5% ethanol and scales removed from both surfaces with delicate brushes. They were placed on a slide in a drop of ethanol, which was replaced by a drop of euparal, and placed under a coverslip. The preparations were left unstained.

For the DNA analyses, one or two legs were removed from each dried specimen and stored in an individual tube, which in most cases contained ethanol. DNA extraction, amplification, and sequencing of the barcode region of the mitochondrial cytochrome c oxidase I (COI) gene (658 base pairs) were carried out in the Canadian Centre for DNA Barcoding, Ontario, Canada, using standard high-throughput protocols (Ivanova et al. 2006; de Waard et al. 2008), which are described at CCDB (2013). Sequence divergence within and between species was calculated using the Kimura 2-parameter model (Kimura 1980) and the neighbour-joining algorithm (Saitou and Nei 1987), as implemented in BOLD (Ratnasingham and Hebert 2007; http://www.boldsystems.org/)

Results and discussion

The genus *Ekboarmia* is a uniform group in regard to the structure of the male and female genitalia and differences between the taxa are minute. This concerns both the external and internal genitalia structures. In the male genitalia the most variable interspecific features, and thus diagnostic in separating the taxa, are the shape of juxta, the angle at which the vesica opens, width of the uncus and the setose ridge in the medial part of valva. In the female genitalia the most variable structures are shape of the lamella antevaginalis, shape of the signum, and presence or absence of a signum.

With regard to the external characters, the group is less uniform. *E. atlanticaria* and *E. fascinataria* form a closely related yet distinguishable species pair, *E. sagnesi* has somewhat similar medial lines on wings but the overall appearance is more uniform. *E. miniaria* sp. n. is the most distinct in its small size, dark brown wing colour, the different course of the postmedial line in the male and most notably, the female is almost uniform dark brown, without markings. Such sexual dimorphism is not apparent in other *Ekboarmia* species. External differences between recognised species are conspicuous and diagnostic, allowing reliable and easy identification.

DNA barcodes were available for the majority of named taxa (Fig. 26). These proved useful and were in agreement with morphological characters. Interspecific distances were found to range from 1.5% to 3.5% in the three examined species of the genus, thus being considerably smaller than in other geometrid genera (on average within genus 10%, see Hausmann et al. 2011). Mean intraspecific variation ranged from 0.15% to 1.35% (average 0.60%). We comment on the genetic data of each species under relevant sections below. The most notable DNA barcode absence is that of *E. fascinataria* and despite extensive efforts, we have failed to get fresh material from North Africa for the genetic work. The most recent *E. fascinataria* specimens in European col-

lections, both public and private, that we managed to locate are from 1979 (in coll. Sommerer). The absence of recent material may be an artefact, and not a true indication of disappearance of *E. fascinataria*, because we simply may not have contacted the right sources. In addition, it is known that collecting activities in many areas in Algeria and Morocco are few and geographically biased to certain locations.

The larvae of the taxa whose biology is known feed exclusively on needles of *Juniper* trees. Larva of *E. atlanticaria* has been found on *Juniperus phoenicea* in Portugal (Corley 2004), Spain (Staudinger 1859), and Sardinia (Flamigni et al. 2016), and is perhaps monophagous on it.

To conclude, four correlating characters sets were useful in delimiting the species (not all character sets were available for all species): external features, genitalia structures (including both the external and internal genitalia), DNA barcodes, and details of life history. Three of these characters sets were available for *E. miniaria* sp. n., supporting its placement in *Ekboarmia*.

Four species are presently considered valid: *E. atlanticaria* (Staudinger, 1859), with one putative subspecies in North Africa, *E. fascinataria* (Staudinger, 1900), *E. sagnesi* Dufay, 1979, and *E. miniaria* sp. n. from Portugal.

Taxonomy

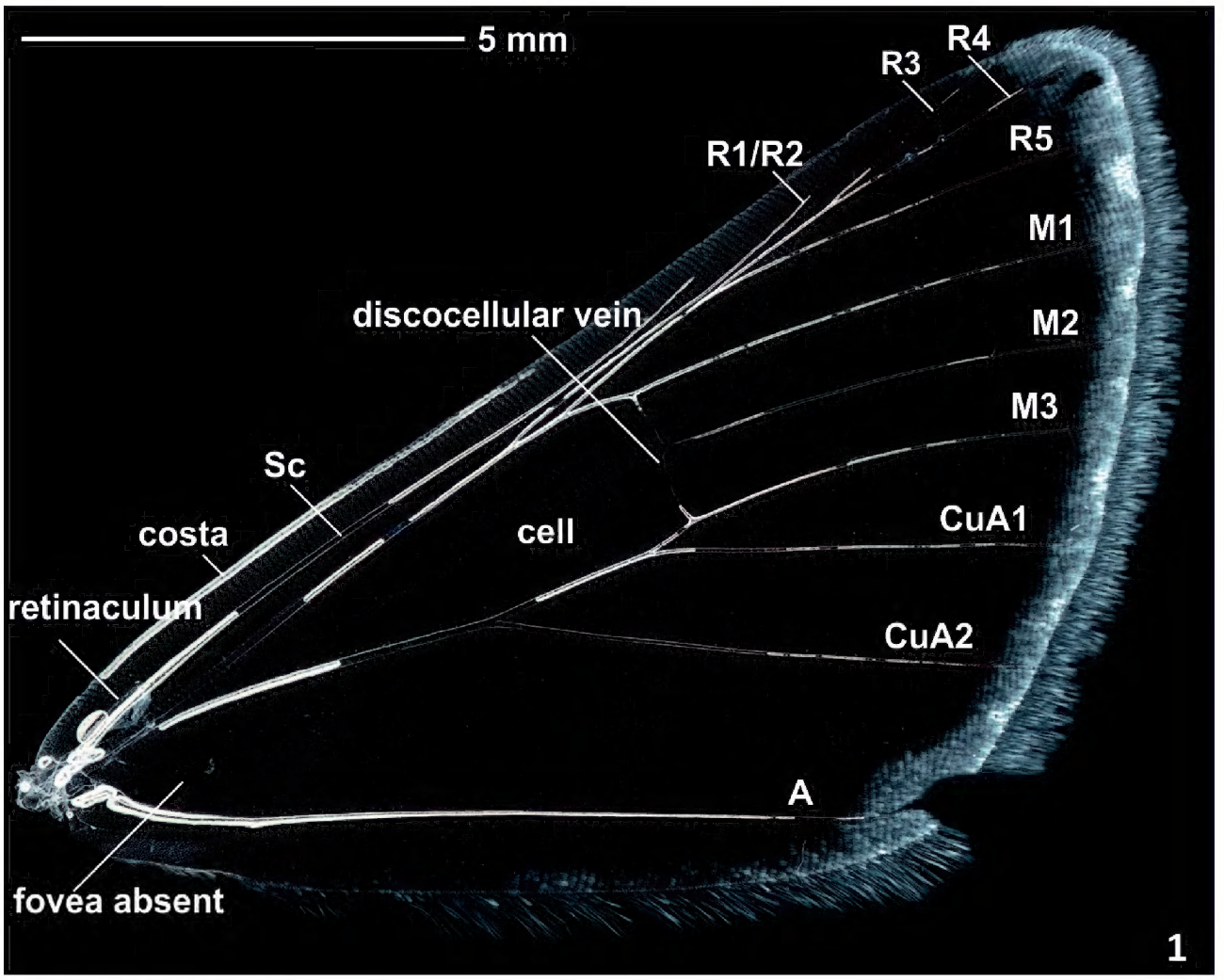
Ekboarmia Wehrli, 1943

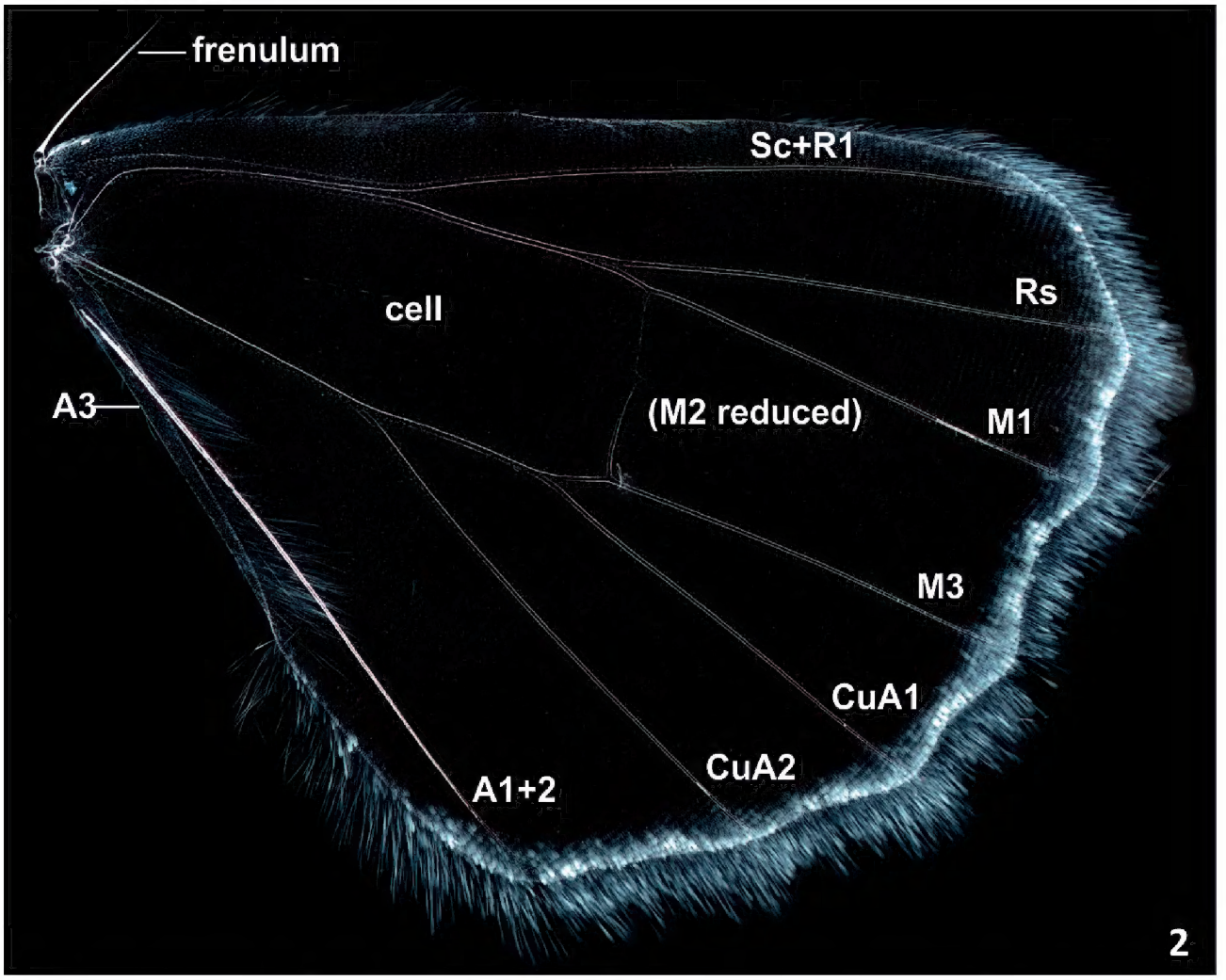
Ekboarmia Wehrli, 1943, Gross-Schmetterlinge der Erde 4 (Supplement.): 517. Type species: *Boarmia atlanticaria* Staudinger, 1859 [replacement name].

Rhoptria Gumppenberg, 1892, Nova acta Academiae Caesareae Leopoldino-Carolinae Germanicae Naturae Curiosorum 58: 299. Type species: *Boarmia atlanticaria* Staudinger, 1859. [Junior homonym of *Rhoptria* Guenée, 1857 (Geometridae: Ennominae)].

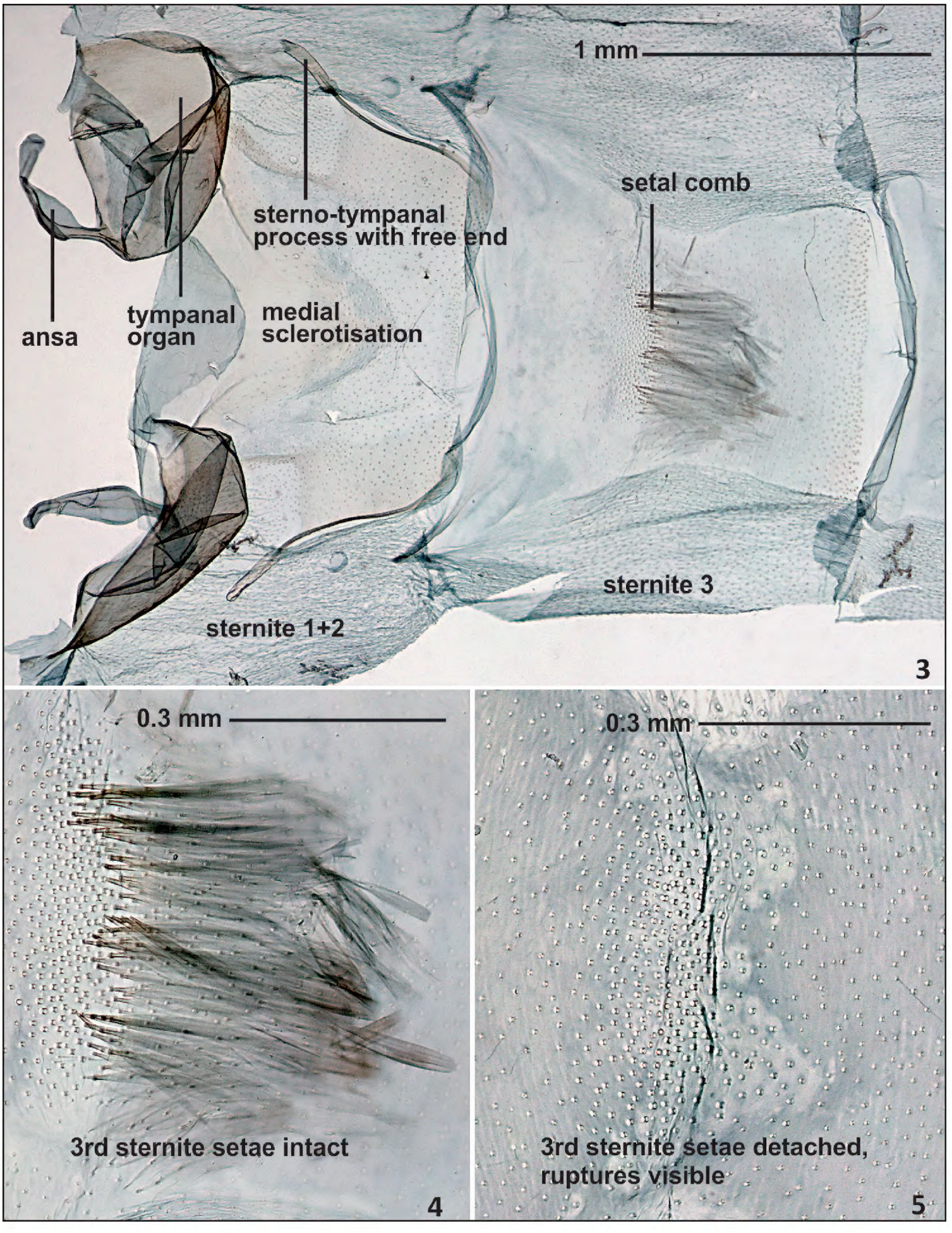
Diversity and distribution. Four species in the West-Mediterranean area, including the French Alps, Iberian Peninsula, the Balearic Islands, Sardinia in Italy, and Morocco, Algeria, and Tunisia in North Africa (Fig. 17).

External characters and abdomen. Medium-sized, wingspan 18–29 mm. Wings grey-brown or different shades of brown, markings blackish. ***Postmedial line prominent***, on forewing it is rather smooth, ***dentate or even zigzag-shaped***, turning inwards near costa, outer margin bordered with whitish. Fovea absent. Venation (Figs 1–2); Sc free, R1 and R2 in forewing completely coincident, often approaching the stem of R3+R4 near its base, rarely anastomosing with it. Common stalk (stem) of R3–R5 remote from upper corner of cell (= origin of M1). R3 and R5 branching off rather basally (proximally). Hindwing with large frenulum. Veins Rs and CuA1 arising remote from upper and lower corner of cell. Space between M1 and M3 large. 3A present, weak, reaching posterior margin just behind middle. ***Male antennae bipectinate*** almost to the tip (5–8 apical segments unpectinated), rami narrow, dorsally unscaled, arising proximally on ventral side from rather long flagellomeres. ***Female antennae filiform***. Frons flat, rather broad, smooth-scaled, palps porrect or slightly curved upwards, rough-scaled, reaching well beyond frons. Haustellum moderately developed. Chaetosemata round type, near eye margin, well developed. ***Male hindtibia with weak hair pencil*** (if not everted, a weak groove visible only), hindtibia of both sexes with 2+2 spurs (index of spurs 0-2-4). ***Setal comb*** (oval field) of minute setae ***present on abdominal sternite 3*** (Figs 3–5), weak sterno-tympanal process laterally on sternite 1+2, with short, free, distally rounded end.

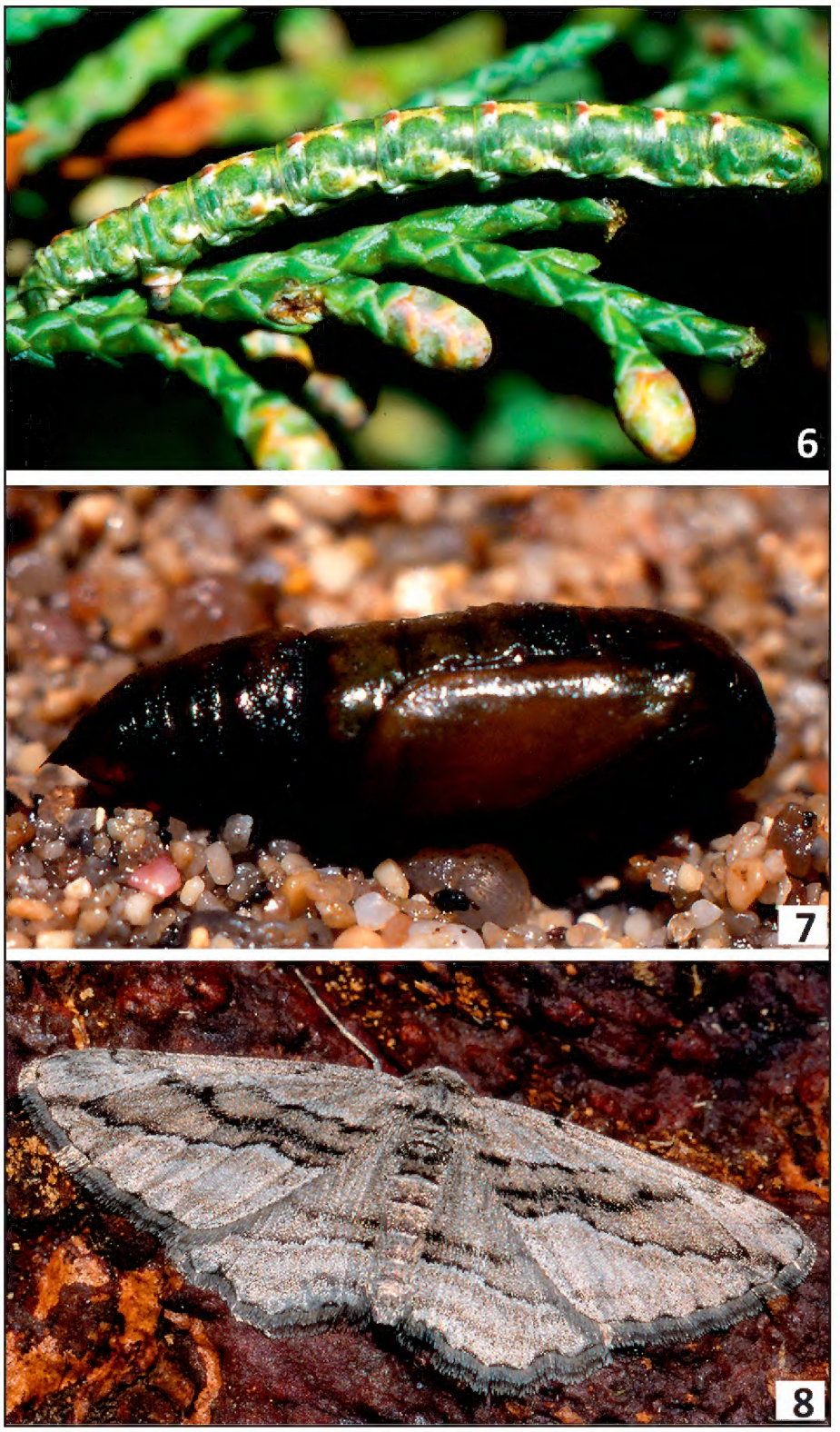




Figures 1–2. Wing venation of *E. atlanticaria* (Staudinger, 1859) male (Portugal: Province Algarve, Salema, 19.iv.2007, slide Sihvonen 2156, coll. Skou). **1.** Forewing fovea is often present in the Boarmiini, but absent in *Ekboarmia*. **2.** Hindwing anal margin was partly folded during slide preparation, hence vein A3 appears at the margin of the wing (=dissection artefact). Veins are partly filled with air (white sections), particularly in forewing.



Figures 3–5. Male abdominal sternite A3 has a small setal comb in *Ekboarmia*, shown here in *E. sagnesi* Dufay, 1979. **3–4.** Illustrated from a specimen from Spain: Leon, Valle de Luna, 1200 m, 2.vii.2011 (slide Sihvonen 2157, coll. Skou). **5.** The setae are detached easily during preparation, revealing an oval field (specimen from France: Dept. Isère, Valle de la Romanche, 1200 m, 22.-23.vi.1999, slide Sihvonen 2095, coll. Skou). The presence of setal comb correlates with presence of sterno-tympanal processes laterally on sternite 1+2, with short, free end. Probably its function is the eversion of the hind leg hair-pencil. Species with a strongly developed hair-pencil always have a strong setal comb and a long sterno-tympanal process.



Figures 6–8. Larva, pupa and adult of *E. atlanticaria* (Staudinger, 1859). Larvae fed in captivity on *Juniperus phoenicea*. Photos by Michael Leipnitz.

Male with tergites 1 and 2 more strongly sclerotised, 8th tergite weakly triangular, posterior margin narrower, other abdominal segments membranous and without modifications. Tympanal cavities without lacinia, medium-sized.

Male genitalia. Uncus triangular, with slightly elongated tip, apex rounded. Socii absent. Gnathos arms fused ventrally, upturned, plate-shaped. ***Valva evenly narrowing towards apex, costa sclerotised, apical part of valva with narrow, setose ridge. Juxta sclerotised, with two large arms, inner and/or distal margins serrate or dentate.*** Saccus elongated, upturned medially. ***Phallus deeply cleft distally***, with dorsal and ventral sclerotised process, latter shorter, gradually narrowing to pointed tip, dorsal one longer, spatulate, ***with narrow base which is bent by everted vesica***. Cae-

cum with sclerotised band on ventral side only, dorsal side membranous. ***Vesica*** slightly enlarged at base, ***without cornuti***.

Female genitalia. Papillae anales rather short, oval, setose. ***Lamella antevaginalis sclerotised, loosely V-shaped transverse band.*** Lamella postvaginalis weakly sclerotised, rounded plate. ***Ductus bursae short, fluted, membranous.*** Colliculum elongate, sclerotised. Corpus bursae elongated, oval, membranous, without sclerotisations. Signum stellate, of medium size, small or absent.

Biology. Probably all species feed on *Juniper* needles. Larva of *E. atlanticaria* has been recorded on (Culot 1919) and found on *Juniperus phoenicea* (Zangheri 1968; Corley 2004) and that of *E. sagnesi* has been reared on *Juniperus communis* (Colomb 2005). Moths are found in a variety of habitat types from coastal dunes to open pine forests to mountain slopes with scattered trees and bushes, from sea-level to 1400 metres.

Immature stages. Larvae of *E. sagnesi* (see Colomb 2005) and *E. atlanticaria* (see Fig. 6 and Spuler 1904) are green needle-mimics that closely match the needles of their *Juniperus* foodplants. Larvae of both species have a row of red dots dorsally, interspersed with yellow and white markings both dorsally and laterally. Pupa typical (Fig. 7), with D2 setae in the cremaster fused and elongated.

Remarks. *Ekboarmia* has recently been classified in Ennominae tribe Boarmiini (Vives Moreno 1994; Leraut 1997; Hausmann et al. 2011). Pupal cremaster with setae D2 fused and elongated supports this placement.

Ekboarmia atlanticaria (Staudinger, 1859)

atlanticaria atlanticaria Staudinger, 1859, Stettiner Entomologische Zeitung 20 (7–9): 218, (*Boarmia*?). Syntypes 3 ♂♂, 3 ♀♀ (MNHU), 1 ♂ (ZFMK; genitalia dissected by E. Wehrli, prep. number 5199). Spain: Andalusia, near Chiclana (examined externally, illustrated also in Albers & Warnecke (1941), plate II, figs. 9, 12 (on p. 332).

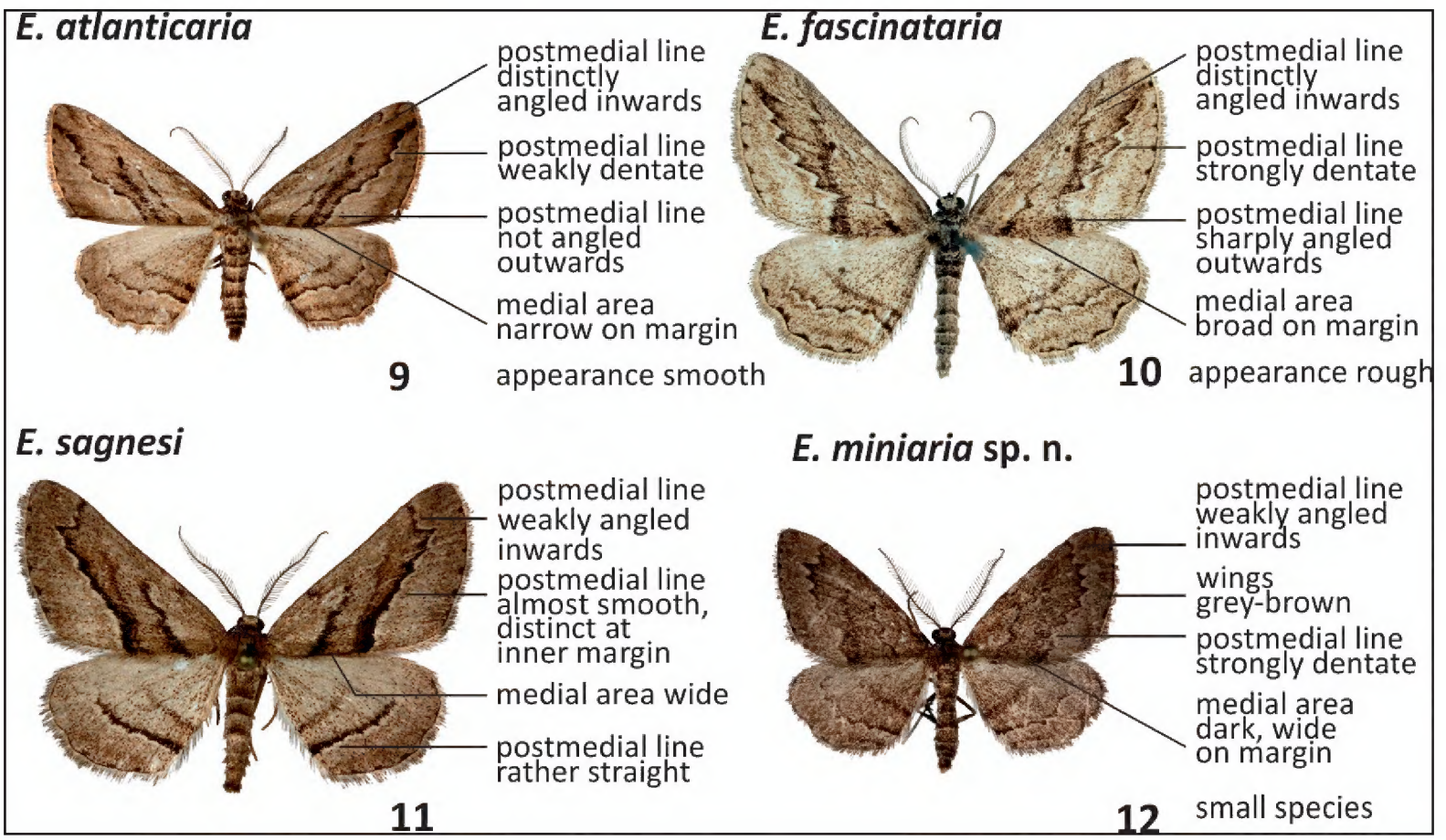
= *atlanticaria gracilis* Albers & Warnecke, 1941, Mitteilungen der Münchner Entomologische Gesellschaft 31 (1): 115, pl. 4, fig. 40, (*Boarmia*). Syntypes 4♂♂, 5 ♀♀ (2 syntype ♂♂ in Universität Hamburg, Centrum für Naturkunde, Germany), [Morocco]: Mehedya (examined externally, based on a photograph in the original description). Downgraded from subspecific rank of *Ekboarmia atlanticaria gracilis* (for instance Scoble 1999; Leraut 2009) to synonymy with *Boarmia*(?) *atlanticaria atlanticaria* Staudinger, 1859 (**syn. n.**), based on the absence of distinct morphological or molecular structures and adjoining distribution area. See Remarks.

atlanticaria holli Oberthür, 1909, Ètudes de Lépidoptérologie comparée 3: 412, pl. 27, fig. 152, (*Hemerophila*). Holotype male (ZFMK), Algeria: Alger [Originally as sp.] (examined, including genitalia, dissected by E. Wehrli, prep. number 5193).

Infrasubspecific names, probably unavailable: *pallidior* Lucas, 1956 (f.).

Examined non-type material. 139 specimens (100♂♂, 39♀♀; data provided in a Suppl. material 1).

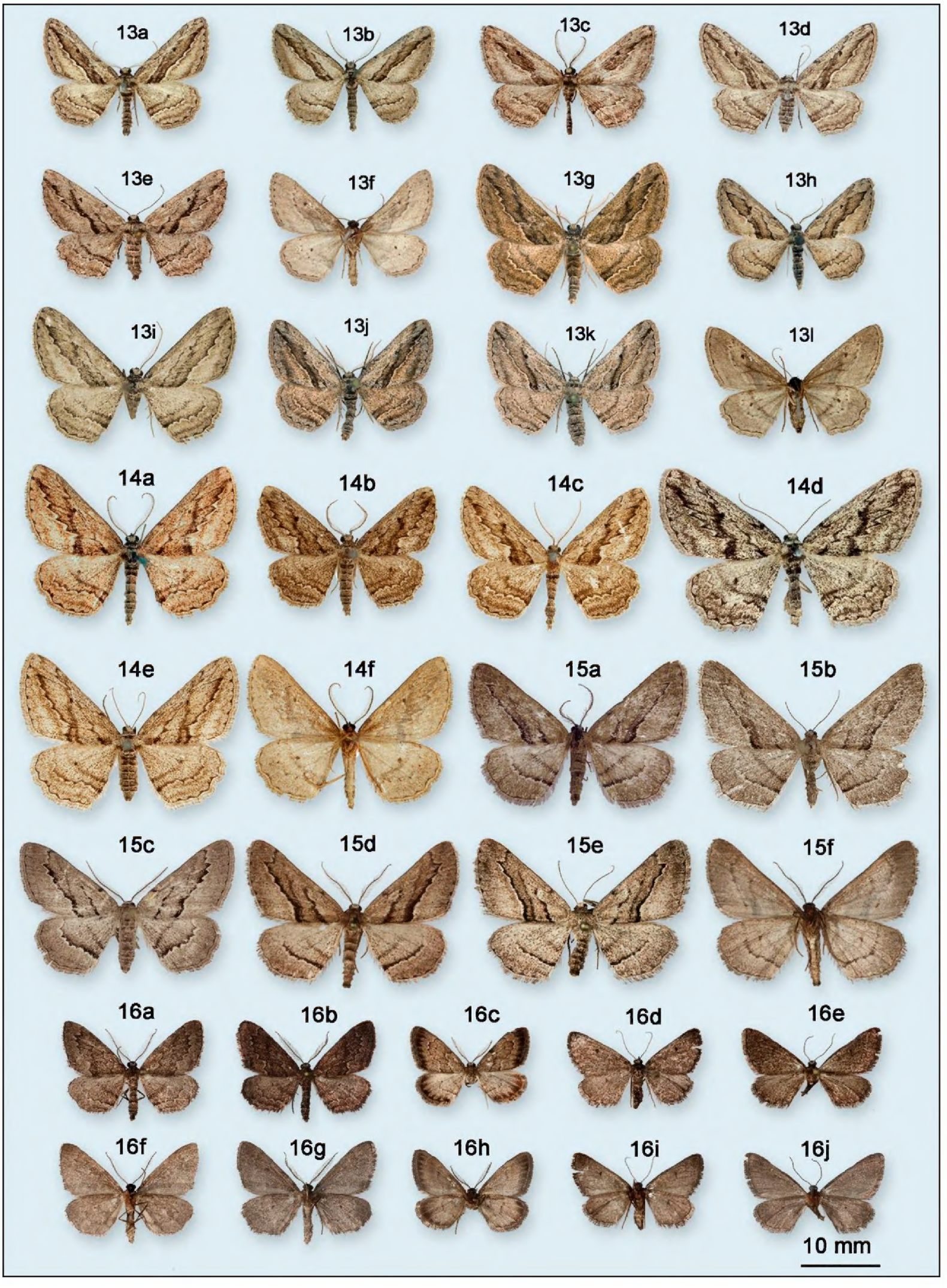
External characters and abdomen (Figs 8, 9, 13). Wingspan 19–27 mm, ***medium-sized species in the genus***. Wings grey-brown, forewing medial area darker brown, ***general appearance somewhat smooth, slightly glossy***. Forewing with antemedial line inclined, deeply V-shaped and acutely angled back towards base but often this part very narrow and only weakly visible. Forewing medial line narrow, often strongest and approaching postmedial line near inner margin. Forewing postmedial line dark-brown to blackish, inclined, ***weakly dentate*** on veins, shallowly curved



Figures 9–12. Diagnostic external characters (indicated) of *Ekboarmia* species. **9.** *E. atlanticaria* male (Staudinger, 1859), Portugal: Salema, 40 m, 19.iv.2007 (coll. Skou). **10.** *E. fascinataria* male (Staudinger, 1900), Algeria: Hammam Righa, April 1928 (coll. ZFMK). **11.** *E. sagnesi* male Dufay, 1979, Spain: Valle de Luna, 1200 m, 2.vii.2011 (coll. Skou). **12.** *E. miniaria* male sp. n., Portugal: Grandola, Ameiras de B., 20.vi.2011 (coll. Skou).

inwards between veins, dark brown, deeply V-shaped and ***angled towards base*** (along vein M1) ***near apex***, angled again towards apex before reaching costa. ***Forewing postmedial line not angled outwards at inner margin and medial area narrow.*** Dark brown to blackish streak in forewing subapical area, often appearing as an extension of postmedial line. Outer margin bordered with whitish. Subterminal line mostly present, but indistinct, dark grey or brown, more or less parallel and close to termen. Terminal line blackish, narrow, often discontinuous, stronger at vein endings. Fringes uniform grey-brown. Hindwing medial line weakly curved, strongest near inner margin, often absent towards costa. Area between medial and postmedial lines often darker than remaining wing surface. Hindwing postmedial line weakly dentate, more strongly curved outwards than medial line, outer margin whitish. Hindwing subterminal line grey or brown, diffuse. Forewing discal spots blackish, small, distinct. Hindwing discal spots smaller. Wings below grey-brown, medial lines diffuse. Postmedial line discontinuous, with blackish dentation, discal spots and terminal line blackish. Course of postmedial line differs from that of upperside, antemedial line hardly visible. Frons, collar, thorax and abdomen concolorous with wings. Antennae concolorous with wings dorsally. Morphological structure of antennae, hindtibia, tympanal organs, tergites and sternites of abdomen as mentioned in generic description.

Variation. Spring generation much larger. Wings vary from grey-brown to different shades of brown. Medial area sometimes completely suffused with dark grey or brown. Terminal line can be continuous or discontinuous. Very rarely specimens occur with stronger dentation on postmedial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line and/or a shallow incision near inner margin, producing a somewhat *fascinataria*-like appearance. We consider such specimens to fall within intraspecific variation of *atlanticaria*. The male syntype of *atlanticaria* from Andalusia in coll. ZFMK shows this feature.

Male genitalia (Fig. 18). ***Uncus narrow, elongated***, apex round. Socii absent. Gnathos arms fused ventrally, upturned, plate-shaped, surface rather smooth, margin round. Valva evenly narrowing towards apex, costa sclerotised, apical part of valva with narrow, setose ridge. ***Juxta arms large, rather narrow, dentate at apex only, base solid.*** Saccus elongated, upturned medially. Phallus narrow, caecum very short. Longer phallus apex elongate-oval, becoming bent when vesica is everted. ***Vesica*** enlarged at base, ***everts at c. 135 degree angle***, without cornuti.

Female genitalia (Fig. 22). Papillae anales slightly elongated, setose. Apophyses posteriores longer (about 1.6×) than apophyses anteriores. ***Lateral arms of lamella antevaginalis weakly sclerotised.*** Lamella postvaginalis weakly sclerotised, rounded plate with caudal, acute process. Ductus bursae very

Figures 13–16. *Ekboarmia* adults. **13a.** *E. atlanticaria* ♂, syntype, Spain: Andalusia, near Chiclana (coll. MNHU); **13b.** *E. atlanticaria* ♂, Italy: Sardinia, Teulada, 8-11.xi.1934 (coll. ZFMK); **13c.** *E. atlanticaria* ♂ Spain: Ibiza, St. Antonio, May 1983 (coll. Sihvonen); **13d.** *E. atlanticaria* ♀, syntype, Spain: Andalusia, near Chiclana (coll. MNHU); **13e.** *E. atlanticaria* ♀, Spain: Cádiz, 10 km NW of Tarifa, Punta Paloma, 30 m, 22–23.v.2006 (coll. Skou); **13f.** *E. atlanticaria* ♂, syntype, Spain: Andalusia, near Chiclana (underside of **13a**, coll. MNHU); **13g.** *E. atlanticaria* ♂, Morocco: Kenitra area, 2 km S of Medyia, 22 m, 6.iv.2011 (coll. Stadie); **13h.** *E. atlanticaria* ♂, Morocco: Tanger, xii 1908 (coll. ZFMK); **13i.** *E. atlanticaria* ssp. *holli* ♂, holotype m, Algeria: Alger, 20.vii.1904 (coll. ZFMK); **13j.** *E. atlanticaria* ssp. *holli* ♂, Tunisia: Grombalia area, 2 km S of Semech, 70 m, 2.iv.2007 (e.o.) (coll. Stadie) **13k.** *E. atlanticaria* ssp. *holli* ♀, Tunisia: Grombalia area, 2 km S of Semech, 70 m, 2.iv.2007 (e.o.) (coll. Stadie); **13l.** *E. atlanticaria* ♀, syntype, Spain: Andalusia, near Chiclana (underside of **13d**, coll. MNHU). **14a.** *E. fascinataria* ♂, Algeria: Hammam Righa, April 1928 (coll. ZFMK) [illustrated in Wehrli (1939–1954) also]; **14d.** *E. fascinataria* ♂, Algeria: Hammam Righa, Juni 1928 [gen. II?] (coll. ZFMK) [illustrated in Wehrli (1939–1954) also]; **14c.** *E. fascinataria* ♂, Algeria: Hammam Righa, Juni 1928 [gen. II?] (coll. ZFMK); **14d.** *E. fascinataria* ♀, holotype, Algeria: Teniet el Had, May-June (coll. MNHU); **14e.** *E. fascinataria* ♀ Algeria: Hammam Righa, April 1928 (coll. ZFMK) [illustrated in Wehrli (1939–1954) also]; **14f.** *E. fascinataria* ♂, Algeria: Hammam Righa, April 1928 (underside of **14a**, coll. ZFMK) [illustrated in Wehrli (1939–1954) also]; **15a.** *E. sagnesi* paratype ♂, France: Hautes-Alpes, Les Fréaux, près la Grave, 1400 m, 20.vi.1979 (coll. Herbulot in ZSM); **15b.** *E. sagnesi* ♀, France: Hautes-Alpes, Usine, Romanche, 1155 m, 24.vi.2009 (coll. Tautel); **15c.** *E. sagnesi* ♂, France: Hautes-Alpes, Usine, Romanche, 1155 m, 15.viii.2009 ex larva (coll. Tautel); **15d.** *E. sagnesi* ♂, Spain: Leon, Valle de Luna, 1200 m, 2.vii.2011 (coll. Skou); **15e.** *E. sagnesi* ♀, Spain: Leon, Valle de Luna, 1200 m, 2.vii.2011 (coll. Skou); **15f.** *E. sagnesi* ♂, Spain: Leon, Valle de Luna, 1200 m, 2.vii.2011 (underside of **15d**, coll. Skou); **16a.** *E. miniaria* sp. n. holotype ♂, Portugal: Grandola, Ameiras de Baixo, 20.vi.2011 (coll. Skou); **16b.** *E. miniaria* sp. n. paratype ♂, Portugal: Grandola, Ameiras de Baixo, 20.vi.2011 (coll. Skou); **16c.** *E. miniaria* sp. n. paratype ♂, Portugal: Alentejo, Lagoa de Santo André, Nature Reserve, 16.ix-10.x.1995 (gen. II) (coll. Skou); **16d.** *E. miniaria* sp. n. paratype ♀, Portugal: Grandola, 15.vi.2009 (coll. Skou); **16e.** *E. miniaria* sp. n. paratype ♀, Portugal: Grandola, 15.vi.2009 (coll. Skou); **16f–16j** = corresponding undersides of **16a–16e**.

short, fluted, colliculum long, narrow. Corpus bursae elongated, oval, without sclerotisations. ***Signum distinctly stellate, of medium size.***

Subspecies *holli*. The holotype is large, greyish-brown (Fig. 13i). In ZFMK is a series of distinctly smaller specimens, collected later in the year, probably a similar phenomenon of seasonal variation as for taxon *gracilis,* see Remarks. The specimens from Tunisia (Fig. 13j, k) are reared and it is therefore difficult to form a judgement upon them. DNA barcodes of Tunisian specimens are distinct from other *E. atlanticaria* specimens (see under Genetic data). No specimens from Algeria were available for DNA barcoding. Historically the subspecies has been delimited to occur in Tunisia and Algeria. We do not propose formal changes to the current classification because more research is needed.

Distribution and abundance (Fig. 17). West-Mediterranean. In Europe only in southwestern Iberian Peninsula, the Balearic Islands, and Sardinia. There is also a record of a single specimen from southern France, undoubtedly a migrant from outside the known distribution area, of which the closest is the Balearic Islands. Outside Europe, in Morocco, Algeria, and Tunisia. In Europe a somewhat local but not rare species, which can be found in limited numbers in its localities.

Phenology. Multivoltine. Recorded from early March to early November with a few additional records in late January, February, and December. Larvae have been found in February (Staudinger 1859), in March, and mid October (M. Corley, pers. comm.). Hibernation probably takes place as egg, larva, and pupa, or a combination of these. The moths are nocturnal and both sexes come readily to light.

Biology. Larva monophagous. It has been found on *Juniperus phoenicea* (Staudinger 1859; Zangheri 1968; Corley 2004).

Habitat. In a variety of habitat types where the foodplant occurs, including coastal dunes as well as non-sandy inland localities. From sea level up to 300 m; according to Redondo et al. (2009) up to 500 m.

Genetic data. BIN: BOLD: AAD7906 (n=11 from Morocco, Portugal and Spain including the Balearics belonging to nominal subspecies) (Fig. 26). In Tunisia (putative subsp. *holli*) with two separate, sympatrically occurring BINs (BOLD: ABZ3161, n=3) diverging by 1.0% and (BOLD: ABZ6474, n=2) and by 2.2% from the Iberian and Moroccan populations. *E. sagnesi* samples were nested within *E. atlanticaria* groups (only short sequences available for the former, see *E. sagnesi*). Distance from *E. miniaria* 3.5% and from *E. sagnesi* 1.5%.

Similar species. Forewing postmedial line weakly dentate and not angled outwards towards posterior margin in *E. atlanticaria* (strongly dentate or zigzag-shaped and sharply angled outwards towards posterior margin in *E. fascinataria*). Forewing medial area narrow at posterior margin in *E. atlanticaria* (wide in *E. fascinataria*). The not closely related *Menophra harterti* (Rothschild, 1912) has striated hindwings and forewing postmedial line is continuous, reaching wing margin below apex. The medial area of the not closely related *Ecleora solieraria* (Rambur, 1834) is not dark and hindwing postmedial line is rather straight (see Flamigni et al. 2007 for illustrations).

Remarks. Taxon *gracilis* from Morocco has been considered valid at subspecies level (e.g., Scoble 1999; Leraut 2009). The description of taxon *gracilis* was based on a series of nine males and females, collected in August and November, and the specimens are very small and dark greyish-brown. In our opinion type specimens belong to a summer or autumn generation, probably developed under dry conditions. Wet conditions in winter and spring yield larger specimens (see Fig. 13g). Same hypothesis has been presented by Wehrli (1943 *in* Wehrli 1939–1954). One specimen from Moroc-

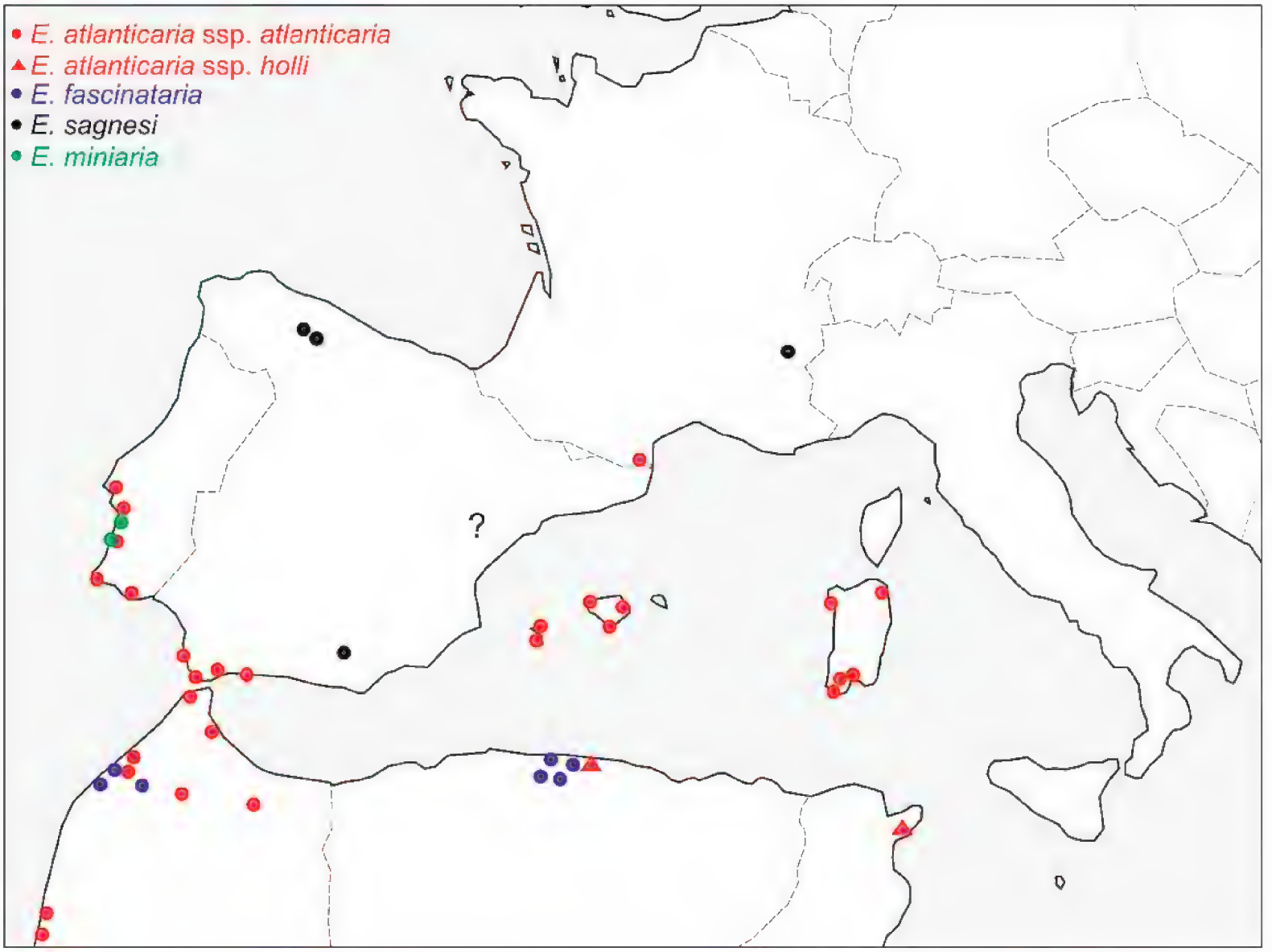


Figure 17. Confirmed records of *Ekboarmia* species. All records of *E. fascinataria* from Europe have proved to be *E. atlanticaria*, therefore this species is removed from the European fauna until a reliable record will be provided. According to current knowledge *E. fascinataria* has a scattered distribution in North Africa, but this may be an artefact of low collecting activity biased towards few sampled areas. An uncertain record of *E. sagnesi* is marked with a question mark, see text for details.

co was available for barcoding and it nested within *E. atlanticaria* subsp. *atlanticaria* specimens from the Iberian Peninsula. Due to similarity in barcodes, adjunct geographical distribution on the opposite sides of Straits of Gibraltar, and presumably seasonal variation of external appearance, we synonymize *Boarmia atlanticaria gracilis* Albers & Warnecke, 1941 with *Boarmia*(?) *atlanticaria atlanticaria* Staudinger, 1859.

Ekboarmia fascinataria (Staudinger, 1900)

fascinataria Staudinger, 1900, Deutsche entomologische Zeitschrift Iris 12: 395, pl. 6, fig. 3, (*Boarmia*). Holotype female (MNHU), [Algeria]: Teniet el Had (examined externally, illustrated also in Albers & Warnecke (1941), plate II, fig. 10 (on p. 332).

Examined non-type material. 65 specimens (22♂♂, 43♀♀; data provided in Suppl. material 1).

External characters and abdomen (Figs 10, 14). Generally as *E. atlanticaria* (see above), but with following differences. Wingspan 24–29 mm, ***large species in the genus***. ***General appearance somewhat rough.*** Forewing postmedial line distinctly dentate, even zigzagged, angled sharply outwards above posterior margin and medial area wide at that margin.

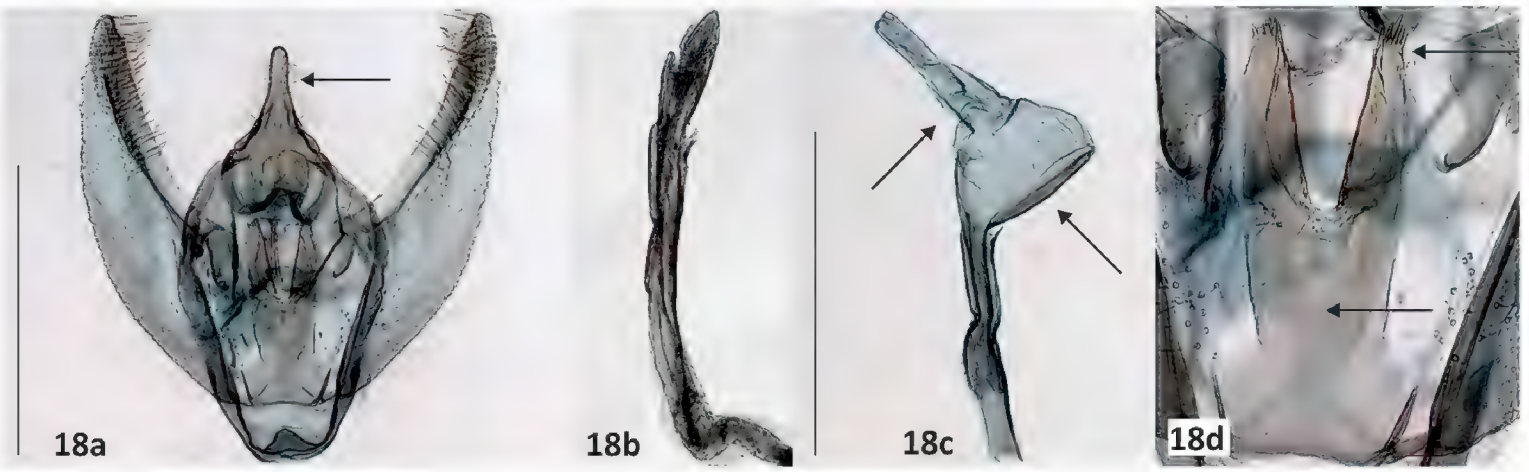
Variation. Wingspan varies quite a lot, the holotype female (collected in May/June) with 29 mm wingspan is the biggest specimen encountered so far. Specimens in the ZFMK collection, collected from March to May in Algeria, Hammam Righa are almost of the same size, while a large series from June consists of distinctly smaller specimens (figured as 1st and 2nd generation in Wehrli 1939–1954). Wing colour varies from grey-brown to grey; males of the Algerian 2nd generation are considerably darker than the females. In addition, a small number of specimens are found in which the forewing postmedial line is not distinctly angled outwards at inner margin. Such specimens, in which this character is somewhat transitional between *E. fascinataria* and *E. atlanticaria*, are nevertheless identified as *E. fascinataria*, as all other relevant characters are typical for this species.

Male genitalia (Fig. 19). Generally somewhat larger and more robust than *E. atlanticaria* (see above), but without any noticeable differences. Base of the juxta tends to be a little longer and narrower, the incision between the furca-arms narrower. The spatulate process at apex of phallus seems to be more elongated and parallel-sided (elongated-oval in *E. atlanticaria*). Large differences as recently published by Leraut (2009, fig. 96) were not observed.

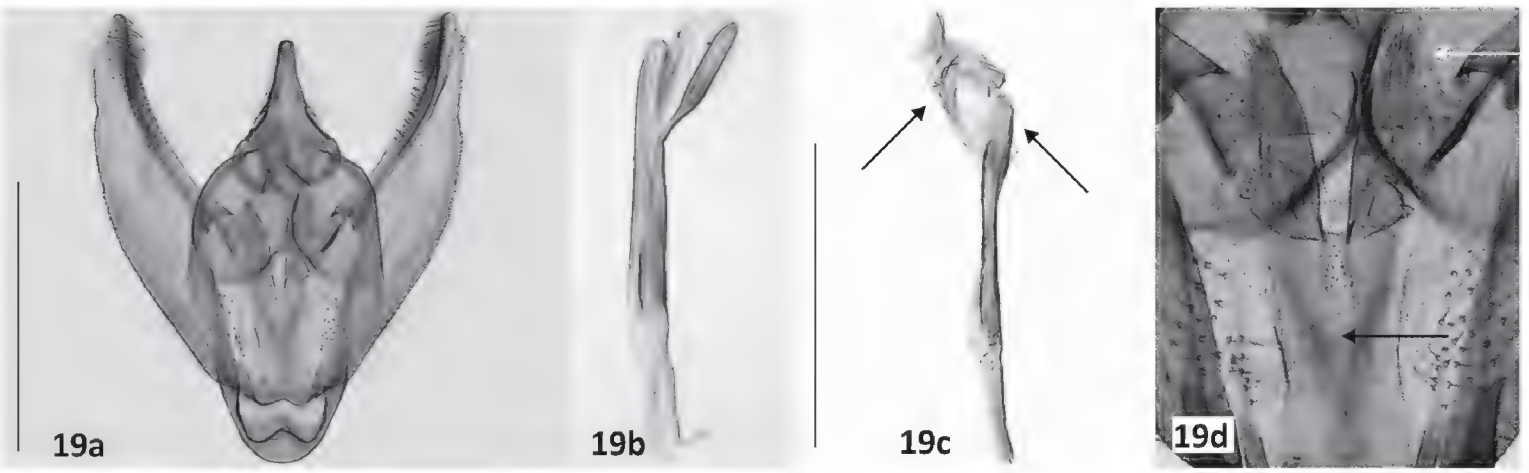
Female genitalia (Fig. 23). Generally as *E. atlanticaria* (see above), but little more robust, with slight, rather gradual differences. Apophyses anteriores and posteriores, and lamella antevaginalis are longer and stronger, lamella postvaginalis is a larger, more equally rounded plate, colliculum longer, but narrower, corpus bursae with a shallow and a more strongly rounded side. Signum a little larger, with fewer but larger marginal teeth. However, all or some of these characters may be due to variation and should be verified by study of more material.

Figures 18–21. Male genitalia of *Ekboarmia* species, diagnostic characters are indicated and explained. Scale (where shown) is 1 mm. **18a.** *E. atlanticaria* genitalia, Portugal: Prov. Algarve, Salema, 40 m, 19.iv.2007, slide PS2053 (coll. Skou); **18b.** *E. atlanticaria* phallus, Portugal: Prov. Algarve, Salema, 40 m, 19.iv.2007, slide PS2053 (coll. Skou); **18c.** *E. atlanticaria* vesica, Portugal: Prov. Algarve, Salema, 40 m, 19.iv.2007, slide PS2053 (coll. Skou); **18d.** *E. atlanticaria* juxta, Portugal: Prov. Algarve, Salema, 40 m, 19.iv.2007, slide PS2053 (coll. Skou); **19a.** *E. fascinataria* genitalia, Algeria: Hammam Righa, May 1928, slide 2307-DS (coll. ZFMK); **19b.** *E. fascinataria* phallus, Algeria: Hammam Righa, June 1928, dissection 5919-Wehrli (in glycerol), mounted on slide by Stüning in 2015 (coll. ZFMK); **19c.** *E. fascinataria* vesica, Algeria: Hammam Righa, May 1928, slide 2307-DS (coll. ZFMK); **19d.** *E. fascinataria* juxta, Algeria: Hammam Righa, May 1928, slide 2307-DS (coll. ZFMK); **20a.** *E. sagnesi* genitalia, Spain: Leon, Valle de Luna, 1200 m, 2.vii.2011, slide PS2157 (coll. Skou); **20b.** *E. sagnesi* phallus, Spain: Leon, Valle de Luna, 1200 m, 2.vii.2011, slide PS2157 (coll. Skou); **20c.** *E. sagnesi* vesica, France: Dept. Isère, Valle de la Romanche, 1200 m, 22.–23. vi.1999, slide PS2095 (coll. Skou); **20d.** *E. sagnesi* juxta, France: Dept. Isère, Valle de la Romanche, 1200 m, 22.-23.vi.1999, slide PS2095 (coll. Skou); **21a.** *E. miniaria* sp. n. genitalia, Portugal: Grandola, Ameiras de B.[aixo], 20.vi.2011, slide PS2050 (coll. Skou), holotype; **21b.** *E. miniaria* sp. n. phallus, Portugal: Grandola, Ameiras de B.[aixo], 20.vi.2011, slide PS2050 (coll. Skou), holotype; **21c.** *E. miniaria* sp. n. vesica, Portugal: Grandola, Ameiras de B.[aixo], 20.vi.2011, slide PS2050 (coll. Skou), holotype; **21d.** *E. miniaria* sp. n. juxta, Portugal: Grandola, Ameiras de B.[aixo], 20.vi.2011, slide PS2050 (coll. Skou), holotype.

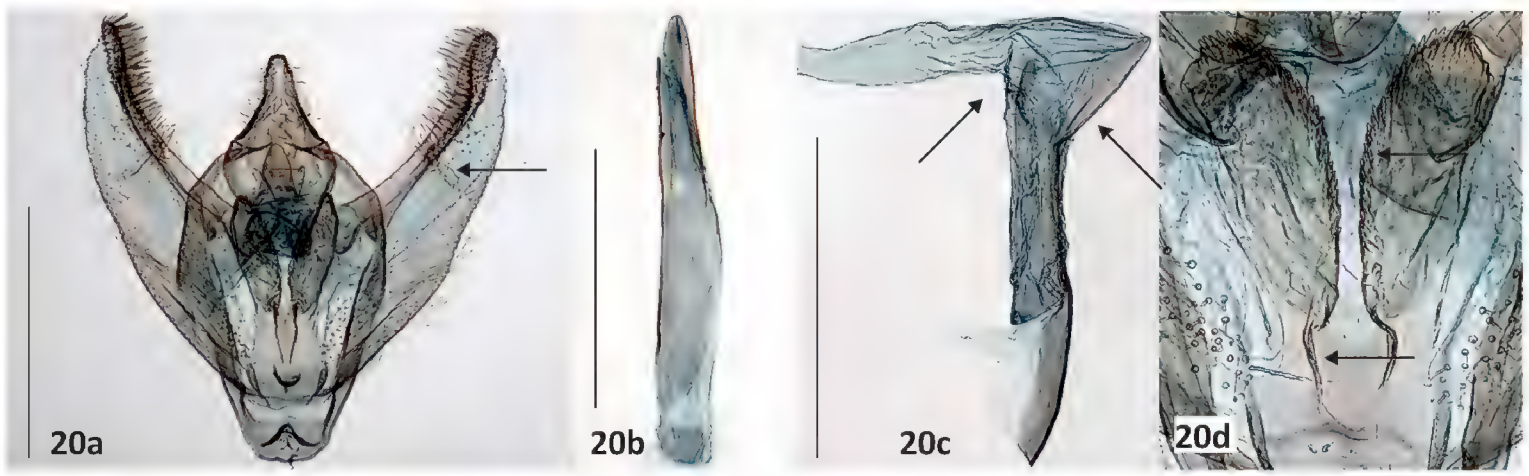
E. atlanticaria * uncus narrow * phallus apex bents when vesica is everted * vesica enlarged at base, opens at 135' angle * juxta arms dentate at apex only, base without grooves



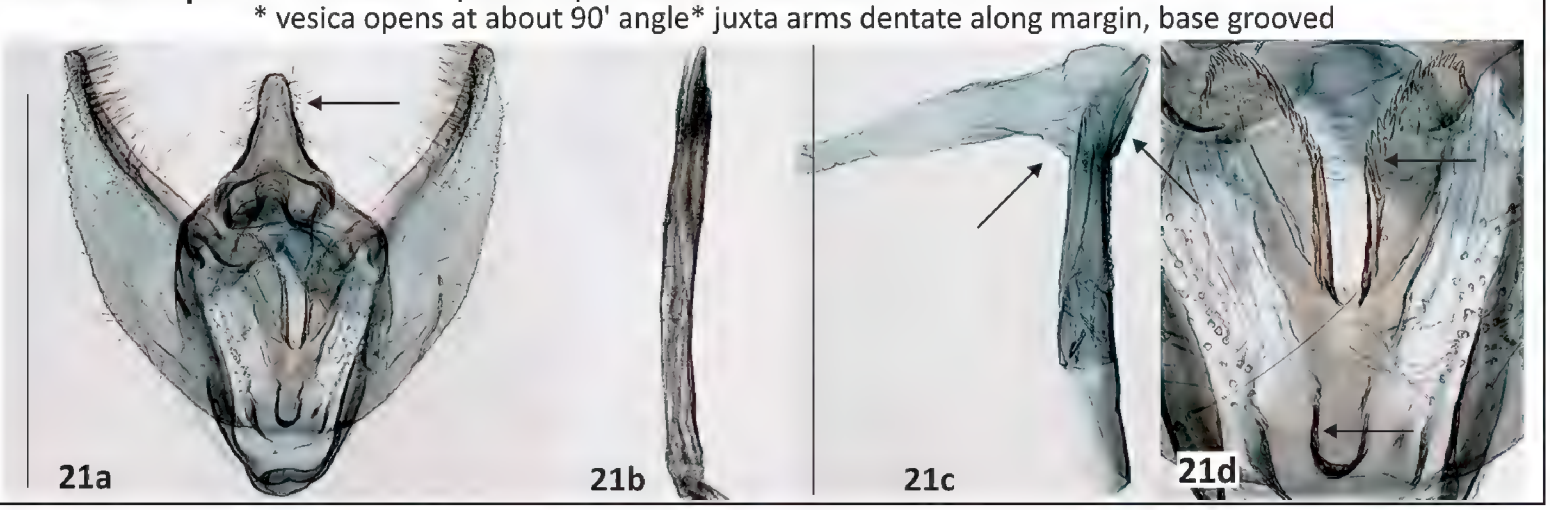
E. fascinataria * uncus narrow * phallus apex bents when vesica is everted * vesica assumably enlarged at base, opens at 135' angle* juxta arms dentate at apex only, base without grooves



E. sagnesi * setose ridge extends into medial part of valva * phallus apex bents when vesica is everted * vesica opens at 90' angle * juxta arms dentate (or smooth) along margin, base grooved



***E. miniaria* sp. n.** * uncus wide * phallus apex does not bent when vesica is everted * vesica opens at about 90' angle* juxta arms dentate along margin, base grooved



Distribution and abundance (Fig. 17). Maghrebian. In Algeria and Morocco. The abundance of the species is unknown. Apparently it is some decades since it was last collected. No confirmed records from Europe, see Remarks.

Phenology. Probably bivoltine. Only rather few and imprecise records available: February, March, April, May, June, October. Rungs (1981) gives February to June and September to November. Wehrli (1939–1954) mentions 'several generations' and figures specimens of a 1st and 2nd generation. Larval time and hibernation are unknown. It is unknown when the adults fly, but probably at night.

Biology. Unknown.

Habitat. Unknown.

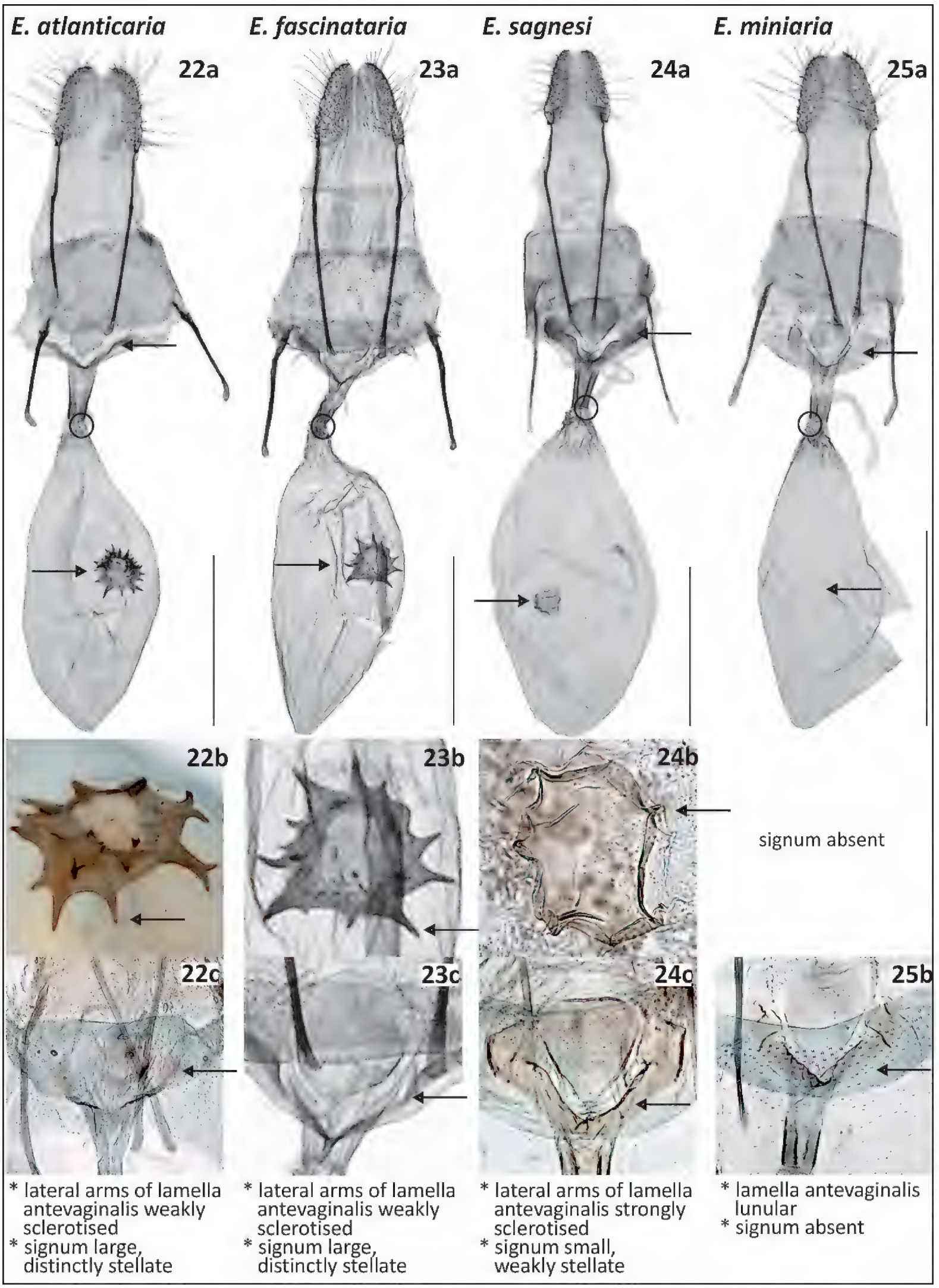
Genetic data. No data available.

Similar species. *E. atlanticaria*, see text above.

Remarks. Although the genitalia of *E. atlanticaria* and *E. fascinataria* are similar, without distinct diagnostic characters, the validity at species level is supported by distinct external appearance and perhaps sympatric occurrence in Morocco and Algeria. This is not unique, as there are examples among the Geometridae and more widely in other Lepidoptera in which external appearance is distinct but the genitalia are rather homogenous (European examples include for instance *Macaria notata – M. signaria*, *Isturgia limbaria – I. roraria*, *Isturgia sparsaria – I. messapiaria* (Skou and Sihvonen 2015), *Nemophora degeerella* (Kozlov et al. 2016)), and DNA barcodes are para- or polyphyletic (Mutanen et al. 2016 pinpoint numerous Geometridae examples), and yet these taxa are considered valid at species level. The currently available data do not support synonymisation of *E. atlanticaria* and *E. fascinataria*. DNA barcode and life history of *E. fascinataria* are not known at the moment. These, when available, are likely to shed more light on the taxonomy.

E. fascinataria has been recorded from France (Llauro, Department Pyrénées-Orientales by Bérard 1995) and it has been included in the French list of Lepidoptera (Leraut 1997) and in Fauna Europaea (Hausmann et al. 2011). In our opinion the specimen in Bérard (1995) is *E. atlanticaria* and also Leraut (2009) states in his more recent publication that the species is not yet known from Europe. Expósito Hermosa (2007, p. 270) explains the identity of a male specimen from the Island of Formentera in the Baleares, recorded on 24 August, 1968. The conclusion is vague (our translation from Spanish): "male genitalia concur with the picture of *E. fascinataria* from Morocco as

Figures 22–25. Female genitalia of *Ekboarmia* species, diagnostic characters are indicated and explained. Scale (where shown) is 1 mm. **22a.** *E. atlanticaria* genitalia, Spain: Prov. Huelva, ESE Mazagon, 20 m, 21.ix.2009, slide 2309-DS (coll. ZFMK); **22b.** *E. atlanticaria* signum, Spain: Prov. Cádiz, 10 km NW of Tarifa, Punta Paloma, 30 m, 22.-23. v. 2006, slide PS2049 (coll. Skou); **22c.** *E. atlanticaria* ostium bursae and adjacent structures, Spain: Prov. Cádiz, 10 km NW of Tarifa, Punta Paloma, 30 m, 22.-23. v. 2006, slide PS2049 (coll. Skou); **23a.** *E. fascinataria* genitalia, Algeria: Hammam Righa, May 1928, slide 2310-DS (coll. ZFMK); **23b.** *E. fascinataria* signum, Algeria: Hammam Righa, May 1928, slide 2310-DS (coll. ZFMK); **23c.** *E. fascinataria* ostium bursae and adjacent structures, Algeria: Hammam Righa, May 1928, slide 2310-DS (coll. ZFMK); **24a.** *E. sagnesi* genitalia, France: Dept. Isère, Valle de la Romanche, 1155 m, 24.vi.2009, slide 2311-DS (coll. C. Tautel, Paris); **24b.** *E. sagnesi* signum, France: Dept. Isère, Valle de la Romanche, 1200 m, 22.-23.vi.1999, slide PS2096 (coll. Skou); **24c.** *E. sagnesi* ostium bursae and adjacent structures, France: Dept. Isère, Valle de la Romanche, 1200 m, 22.-23.vi.1999, slide PS2096 (coll. Skou); **25a.** *E. miniaria* sp. n. genitalia, Portugal: Grandola, 15.vi.2009, slide 2312-DS (coll. ZFMK), paratype; **25b.** *E. miniaria* sp. n. ostium bursae and adjacent structures, Portugal: Grandola, 15.vi.2009, slide PS2051 (coll. ZFMK), paratype.


E. atlanticaria
E. fascinataria
E. sagnesi
E. miniaria
22a
23a
24a
25a
22b
23b
24b
signum absent
22c
23c
24c
25b
* lateral arms of lamella antevaginalis weakly sclerotised
* signum large, distinctly stellate
* lateral arms of lamella antevaginalis weakly sclerotised
* signum large, distinctly stellate
* lateral arms of lamella antevaginalis strongly sclerotised
* signum small, weakly stellate
* lamella antevaginalis lunular
* signum absent

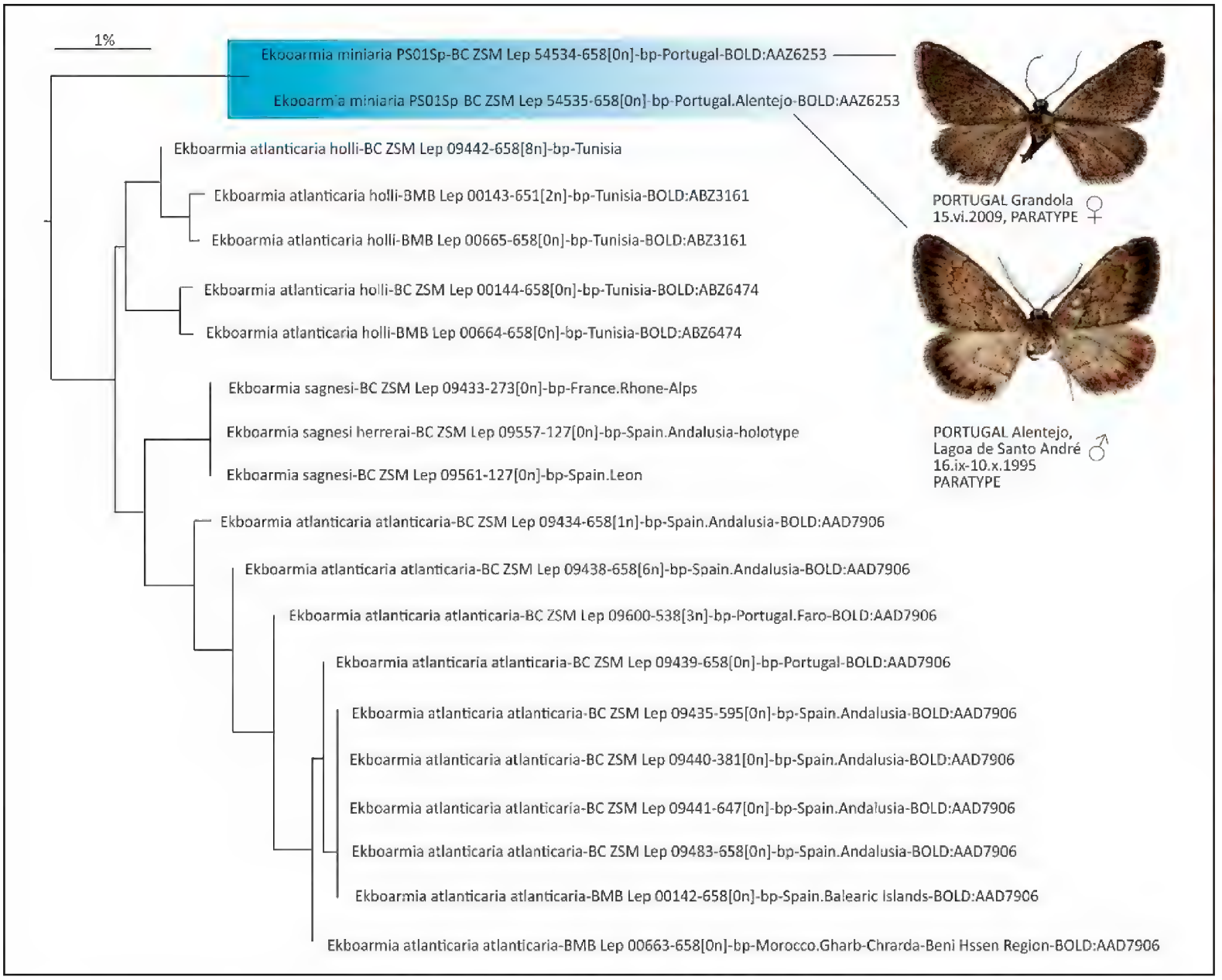

1%
Ekboarmia miniaria PS01Sp-BC ZSM Lep 54534-658[0n]-bp-Portugal-BOLD:AAZ6253
Ekboarmia miniaria PS01Sp-BC ZSM Lep 54535-658[0n]-bp-Portugal.Alentejo-BOLD:AAZ6253
Ekboarmia atlanticaria holli-BC ZSM Lep 09442-658[8n]-bp-Tunisia
Ekboarmia atlanticaria holli-BMB Lep 00143-651[2n]-bp-Tunisia-BOLD:ABZ3161
Ekboarmia atlanticaria holli-BMB Lep 00665-658[0n]-bp-Tunisia-BOLD:ABZ3161
Ekboarmia atlanticaria holli-BC ZSM Lep 00144-658[0n]-bp-Tunisia-BOLD:ABZ6474
Ekboarmia atlanticaria holli-BMB Lep 00664-658[0n]-bp-Tunisia-BOLD:ABZ6474
Ekboarmia sagnesi-BC ZSM Lep 09433-273[0n]-bp-France.Rhone-Alps
Ekboarmia sagnesi herrerai-BC ZSM Lep 09557-127[0n]-bp-Spain.Andalusia-holotype
Ekboarmia sagnesi-BC ZSM Lep 09561-127[0n]-bp-Spain.Leon
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09434-658[1n]-bp-Spain.Andalusia-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09438-658[6n]-bp-Spain.Andalusia-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09600-538[3n]-bp-Portugal.Faro-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09439-658[0n]-bp-Portugal-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09435-595[0n]-bp-Spain.Andalusia-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09440-381[0n]-bp-Spain.Andalusia-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09441-647[0n]-bp-Spain.Andalusia-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BC ZSM Lep 09483-658[0n]-bp-Spain.Andalusia-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BMB Lep 00142-658[0n]-bp-Spain.Balearic Islands-BOLD:AAD7906
Ekboarmia atlanticaria atlanticaria-BMB Lep 00663-658[0n]-bp-Morocco.Gharb-Chrarda-Beni Hssen Region-BOLD:AAD7906
PORTUGAL Grandola
15.vi.2009, PARATYPE ♀
PORTUGAL Alentejo,
Lagoa de Santo André
16.ix-10.x.1995
PARATYPE ♂

Figure 26. Neighbour-joining tree of *Ekboarmia* taxa, with the position of *E. miniaria* sp. n. from Portugal highlighted. Tree was generated under the K2P nucleotide substitution model of 20 barcode sequences as implemented on BOLD. The position of *E. sagnesi* within *E. atlanticaria* is likely to be an artefact, resulting from short barcode sequences. The taxonomic status of *E. atlanticaria* subspecies *holli* from Tunisia needs further research.

illustrated in Albers and Warnecke (1941, p. 137, fig. 1); however, characters of *E. atlanticaria* and *E. fascinataria* share a sufficient number of correlations and an important number of coincidences, so specimens of *E. atlanticaria* and *E. fascinataria* share the same identity in Spain." Due to lack of confirmed records, we propose removal of *E. fascinataria* from the European list until there is a reliable record.

Ekboarmia sagnesi Dufay, 1979

sagnesi Dufay, 1979, Bulletin de la Société entomologique de France 84: 129, figs 1–3, (*Ekboarmia*). Holotype male (MNHN), France: Hautes-Alpes, high valley of the Romanche (examined externally, illustrated in Leraut (2009), plate 47, fig. 18, paratype male genitalia illustrated in Dufay (1979)). Paratype male (coll. Herbulot in Zoologische Staatssammlung München, Germany), France: Les Fréaux, près La Grave,, 1400 m, (H.A.) 20-VI-[19]79, C. Dufay leg (examined externally).

sagnesi herrerai Expósito Hermosa, 2007: SHILAP Revista de Lepidopterologia 35 (138): 269, fig. 1–2, (*Ekboarmia*). Holotype male (coll. A. Expósito Hermosa, Móstoles, Madrid, Spain), Spain, Andalusia: Jaén, Hornillos, Puente de Guada (genitalia examined). Junior synonym proposed by Leraut (2009), here confirmed.

Examined non-type material. 13 specimens (6♂♂, 7♀♀; data provided in a Suppl. material 1).

External characters and abdomen (Figs 11, 15). Wingspan 25–29 mm, ***large species in the genus***. Wings dark grey, sometimes with chocolate-brown tinge, rather uniform in colour. Forewing antemedial line black, narrow, deeply angled inwards below costa. Medial line narrow, barely visible and rather straight, strongest near posterior (inner) margin. ***Postmedial line*** distinct, particularly at inner margin, black, dentate, bordered white outside, ***weakly V-shaped and angled towards base subapically***, angled again towards costa. ***Postmedial line not angled outwards near inner margin and medial area rather narrow. Hindwing medial line almost straight***, not reaching costa. Hindwing postmedial line black, weakly dentate, outer margin bordered with white, weak or absent near costa. Subterminal line absent or very faint. Terminal line faint, continuous. Fringes concolorous with wings, uniform. Discal spots weak or absent. Wings below uniform pale greyish brown, postmedial line and discal spots most visible, antemedial line of forewing absent. Course of postmedial line in forewing does not conform to upperside. Frons, collar, thorax, and abdomen concolorous with wings. Other structures as in *E. atlanticaria*, see above.

Variation. Forewing medial area concolorous with wings or darker, particularly near inner margin. Forewing postmedial line can be rather smooth or distinctly dentate.

Male genitalia (Fig. 20). Generally as *E. atlanticaria* (see above). Setose ridge extends into medial part of valva in *E. sagnesi* (medial ridge absent in other *Ekboarmia* species). Vesica opens at 90 degree angle (at 135 degree angle in *E. atlanticaria* and *E. fascinataria*). Juxta arms broader distally than basally, dentate or smooth along inner margin, always dentate distally, base with roundish lobe in *E. sagnesi* (juxta arms gradually tapered towards apex, margin dentate at apex only in *E. atlanticaria* and *E. fascinataria*, base with elongated lobe in *E. miniaria*).

Female genitalia (Fig. 24). Generally as *E. atlanticaria* (see above). Lamella antevaginalis broader. Signum small, weakly stellate in *E. sagnesi* (signum distinctly stellate in *E. atlanticaria* and *E. fascinataria*, signum absent in *E. miniaria*).

Distribution and abundance (Fig. 17). Southwest European. Only few and isolated populations are known: In Val de la Romanche, Dept. Hautes-Alpes, France, from Valle de Luna and Velilla de Rio Carrión (Javier Gaston, pers. comm.), both in Leon Province and Sierra de Cazorla, Jaén Province, Spain. The species is unknown outside Europe. An apparently extremely local species that appears as single specimens or in limited numbers.

Weiss (1920) listed *E. atlanticaria* from Spain, Sierra de Albarracin. We have not been able to trace the Weiss Collection, and since *E. atlanticaria* has not been reported since from that area, which is unlikely to contain habitats suitable for this species, Weiss's record is surely based on a misidentification. Redondo et al. (2009) mention Weiss's record from Sierra de Albarracin also, suggesting it is possibly *E. sagnesi* because potentially suitable habitats are present in the area (this record is shown as a question mark in the map). *E. sagnesi* should certainly be looked for in Sierra de Albarracin.

Phenology. Uni- or bivoltine. In Spain from early June to mid-July, in France from early May to late June and in August. Larval period and method of hibernation are unknown. The moths are nocturnal and come to light.

Biology. Larva monophagous on *Juniperus*. Reared on *Juniperus communis* (C. Tautel pers. comm., Colomb 2005), but other *Juniperus* species are possible foodplants.

Habitat. Mountain slopes with scattered trees and bushes. In France from 1150 to 1400 m, in Spain known from around 1200 to 1400 m. In Spain, Leon found on slopes with *Juniperus sabina* (Tomas Molina, pers. comm.).

Genetic data. *E. sagnesi* specimens (n=3 from France and Spain, including the holotype of taxon *herrerai*), grouped within *E. atlanticaria*, as the sister-group to *E. atlanticaria* specimens from the Iberian Peninsula, the Balearic Islands and Morocco (Fig. 26). Distances from *E. atlanticaria* 1.5% (from its Tunisian populations 2.0%) and 3.9% from *E. miniaria*. The barcodes of *E. sagnesi* were incomplete, only 127–273 bp in length, so the results must be considered tentative.

Similar species. There are no similar species in Europe. Rather uniform greyish brown colour and small angle in forewing postmedial line near costa are diagnostic.

Remarks. Colomb (2005) illustrated a superficial, hand-drawn picture of the female genitalia, which shows an unusual curved, probably sclerotised structure on the corpus bursae. We have not observed such structure in any of the *E. sagnesi* specimens examined, and the signum (which Colomb apparently did not illustrate) of *E. sagnesi* is weakly stellate, not resembling such curved structure. Second author was able, through the courtesy of Claude Tautel, to re-examine the badly damaged genitalia, preserved in a tube with glycerol pinned under the moth. Remaining sclerotised parts clearly showed the identity with *E. sagnesi*, membranous parts were largely lost, even though attempts were made to make them visible by staining. The curved, probably sclerotised structure was loosely floating around in the tube and not attached to a membrane. It probably was lying on the bursa only accidentally when the original drawing was made.

Ekboarmia miniaria sp. n.

http://zoobank.org/455E1158-2ACE-4390-8BB6-A345174D381D

Type-locality and type-specimen. Holotype male, pinned, with genitalia on a separate slide. Original labels: HOLOTYPE/ *Ekboarmia/ miniaria* [red rectangle label]; Portugal Grandola/ Ameiras de B.[aixo] [38°14.29'N; 8°32.42'W]/ 20.vi.2011/ A. & Z. Laštůvka lgt.; Prep. number 2050/ Pasi Sihvonen (in coll. Skou, to be deposited at Zoological Museum, University of Copenhagen, Denmark).

Paratypes 5 ♂♂ and 5 ♀♀, all with same type label: PARATYPE/ *Ekboarmia/ miniaria* [red rectangle label]. One female will be deposited at ZFMK, one male at NHM, one male at ZSM and all remaining specimens are currently in coll. Skou, to be deposited at Zoological Museum, University of Copenhagen, Denmark. Paratype label data: 4 ♂♂, 2♀♀: same label data as the holotype. 1 ♂: P.[ortugal] Alentejo/ Lagoe St André [Lagoa de Santo André]/ Nature Reserve [38°5.12'N; 8°46.57'W] / 16.ix-10.x.[19]95/ B. Elliott; genit. prep. m/ 496/ B. Goater. 3 ♀♀: Portugal/ Grandola/ 15.vi.2009/ A. & Z. Laštůvka lgt.

External characters and abdomen (Figs 12, 16). Wingspan males 17–19 mm (n=6), females 17–18 mm (n=5), ***smallest species in the genus***. Sexual dimorphism apparent. ***Male dark greyish-brown or rather blackish-brown***, medial area darker. Forewing antemedial line absent. Medial line blackish, weakly dentate, turned inwards on costa. ***Postmedial line distinctly dentate***, angled inwards before costa, outer margin very narrowly bordered with whitish. Medial area dark, wide on inner margin. Subterminal line absent. Terminal line narrow, black-

ish, slightly widened at vein endings. Fringes grey-brown, unicolorous. Hindwing medial area paler, postmedial line less dentate. Forewing discal spot small, distinct, dark brown. Wings below uniform grey-brown, postmedial line weakly visible. Female almost uniform grey-brown, postmedial line weakly visible, dark brown, dentate. Forewing discal spot small, distinct, dark brown. Hindwing discal spots smaller. Wings below uniform grey-brown, discal spots minute and dark brown. Frons, collar, thorax, and abdomen concolorous with wings, irrorated with grey. Abdomen paler ventrally. Male antennae bipectinate, female antennae filiform. Hindtibia with 2+2 spurs, male hindtibia not swollen, with very small hair pencil (if not everted, a weak groove visible only). Tympanal organs medium-sized, not meeting medially, slightly smaller in female. Male 8th tergite weakly triangular, posterior margin narrower. Other sternites and tergites of both sexes unmodified.

Variation. June specimens are dark brown; the specimen taken in October is light brown, except terminal area, which is distinctly dark brown (see Figs 16c, h). It is not clear whether this specimen shows the normal appearance of the second generation or whether it is a strongly aberrant individual.

Male genitalia (Fig. 21). Generally as in *E. atlanticaria*, but smaller. Uncus wide in *E. miniaria* (similar, but a little less wide in *E. sagnesi*, narrow in *E. atlanticaria* and *E. fascinataria*). Phallus apex does not bend when vesica is everted (bends when vesica is everted in *E. atlanticaria*, *E. fascinataria* and *E. sagnesi*). Vesica opens at about 90 degree angle (at about 135 degree angle in *E. atlanticaria* and *E. fascinataria*). Juxta arms broader apically than basally, dentate along inner margin, base with elongated lobe (juxta arms tapering apically, dentate at apex only, base solid in *E. atlanticaria* and *E. fascinataria*; juxta arms broader apically, dentate (or smooth) along inner margin, base with roundish lobe in *E. sagnesi*).

Female genitalia (Fig. 25). Generally as in *E. atlanticaria*, but genitalia distinctly smaller. Lamella antevaginalis is curved, broad band in *E. miniaria* (lateral arms of lamella antevaginalis weakly sclerotised in *E. atlanticaria* and *E. fascinataria* and strongly sclerotised in *E. sagnesi*). Signum absent in *E. miniaria* (signum distinctly stellate in *E. atlanticaria* and *E. fascinataria* and weakly stellate in *E. sagnesi*).

Etymology. The species name *miniaria* (word stem based on the Latin "minima", an adjective in the nominative singular), refers to the small size of the species. The wingspan and genitalia of both sexes are smaller than in any other *Ekboarmia* species.

Distribution and abundance (Fig. 17). Endemic to Portugal, where it is presently known from only two localities in the southern part of the country. Seven specimens were found in one night (20.vi.2011).

Phenology. Possibly bivoltine. So far, the species has been recorded in mid-June and once between 16 September and 10 October. Nothing is known about larval time and hibernation. The moths are nocturnal and come to light.

Biology. Unknown.

Habitat. Open pine forests (*Pinus pinaster*) on sandy soil with undergrowth of herbs and scattered bushes, including *Halimium atriplicifolium*, *Stauracanthus genistoides*, and *Cistus psilosepalus* among the dominant species. One of the two known localities had suffered a bushfire, probably 8–10 years earlier. Found close to sea level and at 90 m (Figs 27–29).

Similar species. There are no similar species in Europe.

Genetic data. BIN: BOLD: AAZ6253 (n=2 from Portugal) (Fig. 26). Intraspecific variation low (0.15%). Distances from *E. atlanticaria* 3.5% and from *E. sagnesi* 3.9%.

Figure 27. Habitat of *Ekboarmia miniaria* sp. n., showing the location where the first specimen was found in 1995 by Brian Elliott. Portugal: Lagoa de Santo André, 24.ix.2009. Photo by Peder Skou.

Figure 28. Habitat of *Ekboarmia miniaria* sp. n., showing the location where majority of specimens have been found. The dominant pine is *Pinus pinaster*. In the undergrowth *Halimium atriplicifolium*, *Stauracanthus genistoides* and *Cistus psilosepalus* are among the dominant species. Portugal: Grandola, Ameiras de Baixo. Photo taken on 16.vi.2009 by Zdenek Laštůvka.

Figure 29. Habitat of *Ekboarmia miniaria* sp. n., showing the location where majority of specimens have been found. The dominant pine is *Pinus pinaster*. In the undergrowth *Halimium atriplicifolium*, *Stauracanthus genistoides* and *Cistus psilosepalus* are among the dominant species. Portugal: Grandola, Ameiras de Baixo. Photo taken on 21.vi.2011 by Zdenek Laštůvka.

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Supplementary material 1

Examined non-type material.

Authors: Peder Skou, Dieter Stüning, Pasi Sihvonen

Data type: MS Excel file

Explanation note: Examined non-type material.

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